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MARKETING INNOVATIONS

Reprinted from Agricultural Markets in Change,
Agricultural Economic Report 95

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October 1966

MARKETING INNOVATIONS

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Agricultural Economists

INTRODUCTION

In the briefness of a generation, the face of much of our world has changed. We span the States more swiftly than the sun. Sitting in our living rooms, we watch actual events take place on other continents. The dark side of the moon is ours to observe. We live, play, work, and even worry amid conditions undreamed of 50 years ago. We shop to music. Food and clothing in plentiful supply beckon us to attractive marts. We fill shopping carts from mountainous piles of merchandise. The existence and availability of these miracles of farm and market, we take for granted. But their impact has been vast. Fast-moving and far-reaching changes occur in the economic system as innovation after innovation enters the stream of man's activities to satisfy his needs and fulfill his dreams.

Fruits of change grow wherever seeds of progress are planted. As we look about us, we see evidence of this truth. A renowned economist, Joseph Schumpeter, has written (26), "Innovation is the outstanding fact in the economic history of capitalistic society. It is largely responsible for growth which we sometimes attribute to other factors. Further innovations result from previous innovations, or are directly produced or made possible by them." 1/ This chapter cites many examples to reinforce Schumpeter's opinion. Changes in farm marketing are evaluated. Those factors which are at work in shaping the course and formulating the structure of the farm marketing industry also motivate its decision-makers.

Definitions and Classification of Innovations

An innovation is the discovery and effective application of a new idea to a product, method, or organization. An innovation is not just an invention. Invention is the discovery of a device, contrivance, or process. But unless the invention enters into the economic system, it is not effective. Development and promotion carry inventions on into actual performance and exploit them for business applications. So, an innovation is the combination of research, market promotion, and market use.

Innovations may belong to one or more of three general types according to the changes they make. First, they may be techniques or devices that cut costs. Innovations of this type provide the same final product or service as previously, except that an operation or process is carried out differently to reduce costs per unit of output. An example is the introduction of fork-trucks in handling agricultural products. Fork-trucks, as such, were not new, having been in general use in industry and commerce for many years before food handlers discovered their cost-reducing possibilities. Innovators developed pallet boxes to use with potatoes, citrus fruits, and apples. They designed slings for use with flour, sugar, beans, and other bagged items. Output per man-hour increased as capital was substituted for labor. Innovations of this type frequently lead to expansion in the total output.

The second type of innovation is the introduction of new products or services. Consumer demand for a new product may be expressed or latent. Examples of

1/ Underscored numbers in parentheses refer to Selected References, p. 55.

products catering to latent demands are the recently introduced free-flowing flour and brown sugar. Introduction of food-handling and cooking changes such as boil-in-the-bag frozen foods may indirectly cut costs by increasing volume of sales. Other new products or services may not affect costs at all, or may even raise them. Increased services, when introduced alone, tend to increase both costs and product prices. But when these services are joined with new techniques, costs and product prices may remain the same or even be reduced.

The third type of innovation consists of changes in business organization and market structure. These innovations are quite different from the two types discussed above. They include changes in business combinations; integration, both horizontal and vertical; competitive devices such as promotion, tie-ins, and price changes; and other factors affecting the way a business is handled. Involved are grades, standards, quality, and brands used by business firms to gain an advantage in the market. A brand, for example, is a name or symbol that stands for a certain quality or standard of product. Generally, a brand belongs to a single firm, although a brand such as Sunkist may be used by a group of firms--cooperatives, in this instance. Use of company brands is a competitive innovation.

Another example of the structural type of innovation is the growth of cooperatives. Because the people who use cooperatives also own them, there are differences in control and in distribution of earnings. Tax treatment distinguishes them from other forms of corporations.

Frozen orange juice concentrate has been an innovation involving all three types of changes. About two decades ago this product was new, as was the process used to produce it. This new process reduced transportation and handling costs since much of the water was no longer shipped. Because the concentrate could be stored, the selling season spread out over more of the year. This, too, reduced costs. These cost savings led to lower prices, which in turn caused consumers to buy more juice. The ensuing increase in volume further lowered costs at all levels of marketing. The new product also led to changes in marketing structure. Cooperatives were formed for the express purpose of processing and selling the concentrate. Competitive relationships changed. Companies applied new merchandising techniques to the product. New brands appeared; some retailers developed their own company brands and started to process the product themselves.

An innovation need not be completely new to be successful--just new to the economic system into which it is introduced. In fact, many innovations are not new--just new to the market. Samuel Johnson expressed it: "Wheresoe'r I turn my view, all is strange, yet nothing new."

Economic Theories of Innovation

The following section outlines a few of the common theories of innovation. These are attempts to explain how and why marketing changes get started; how innovations affect the marketing economy, profit expectations, and investment; and the part that innovations play in enabling our society to reach higher levels of consumer satisfaction and well-being. Everyone concerned with economic development is interested in the why and how of innovations and their effects.

The theories reviewed here are not limited to innovations in agricultural marketing. They deal with innovation per se. Innovations play a key role in changes that affect not only firms engaged in the marketing process, but also producers and consumers

of farm products. As a matter of necessity, food processors and handlers keep up to date with new ideas in their field. But farmers, too, cannot ignore new handling and processing procedures and new uses of their products. Changes in marketing techniques may affect the relative market values of the different varieties and types of food products they raise. Consumers, of course, are always faced with numerous new products and packages. They have to choose between this or that food, this service or that one. All three of these groups need to keep current with and understand the innovations that create changes in marketing.

Schumpeter regarded innovations as the prime movers of economic growth and activity (26). According to him, they introduce change into the economy. Soon after an innovation diffuses throughout the economy, other businessmen may imitate the product, process or change. The innovation may, by its entry into the market, make existing products, services, or structures obsolete. This sets in motion forces that disturb the equilibrium. Cumulative demand for productive equipment and working capital enlarges the demand for investment. Capital associated with the displaced technology becomes obsolete. The emerging firm or industry hires new employees. Employees need to be mobile and adaptable to change in order to move from the replaced industry to the new one.

One innovation may not bring about a wave of investment. However, a particular innovation may create a psychological climate for other inventions that have been "on the shelf." These are now placed on the market as their owners become optimistic. If these innovations are successes, copying and imitating make the total effect even greater. An upward swing may continue until the products that have been on the shelf are exhausted. The expansion phase depends in part upon the length of time necessary to install productive equipment. When the investment flow diminishes, expansion is checked.

The innovating leader reaps profits for a limited time, but society may derive a permanent benefit through a general reduction in prices if the innovation has been of the cost-cutting type. Thus, in Schumpeter's view, cost-cutting innovations benefit not only the individual entrepreneur, but also consumers and society at large.

Clark stressed competition as a necessary ingredient for development of innovations (6). First, innovations result in profits; then they allow lower costs. Lower costs result in reduced prices. Competition then forces other firms to adopt the innovation and the resulting superior methods of production diffuse throughout the economy. Many innovations of the structural type actually limit competition, but Clark did not discuss these.

Marx saw in innovations the eventual cause of collapse of the capitalistic system. He believed technological change would reduce the need for skill, and low wages and unemployment would result. His pessimistic predictions have not been fulfilled; in fact, just the opposite has occurred. Sumner Slichter shows that demand for skills increases as automation progresses (27). Greater productivity has not caused permanent unemployment, but rather higher wages and shorter hours. In Western countries, innovational changes have helped to produce a stable middle-class society. Some of the political revolutions Marx predicted have come, but these have most often been in societies where technological changes were slowest to arrive.

Bain says firms react differently to other firms' innovations depending on whether they operate under monopoly or competitive conditions (3). Since firms innovate to increase profits, they estimate the lag of time until their competitors can copy their innovations, and introduce them only when there is adequate time for profits

to be made. A monopolist, partially protected from other firms, is more likely to innovate since his time lag is longer. Thus, Bain says, a more rapid rate of innovation may occur under conditions of monopoly than under competition. Monopoly and innovation are interrelated in that innovation may open the road to a new monopoly. It also may reduce the value of an old monopoly. Pursuit of monopoly profits may be a primary incentive to innovation.

Baumol classifies innovations as follows: (1) New goods, (2) new methods of production, (3) new markets, (4) employment of new sources of supply factors, and (5) reorganization of an industry or part of an industry (4). Innovations, brought about by the profit motive, are the primary source of excess profits. They lead to continuing normal profits as well. Thus, the entrepreneur is always under pressure to innovate and not allow his business to stagnate. Innovation encourages a firm to accumulate capital, since introduction of an innovation requires new capital. Of course, the entrepreneur may not always use his own capital, but his own accumulated wealth helps him in raising the money by loans or stock sale.

Papandreau feels new-product and cost-reducing innovations maintain competitive pressures (20). Vitality in the economy depends upon change. Change depends on innovations. Therefore, innovations keep an economy alive and growing. In an economic community of this type where change does occur, it is possible to maintain the goal of workable competition--if buyers and sellers stay approximately equal in power.

Heady classifies farm innovations as biological and mechanical. Biological innovations increase farm output from a given land base (14). Mechanical innovations substitute capital for labor. Many changes are of both types. In the short run, Heady sees innovations as reducing costs, and in the long run as increasing production.

Other economists, recognizing the importance of innovation in business, maintain that innovation plays a key role in expectations. Investment capital naturally goes to firms and industries that innovate. New investment optimism pervades the economy and causes other investments to take place. Since innovators seek profits, Government tax policies can be a determining factor in encouraging or limiting development of innovations.

Most economic writers agree that innovations are important to both supply and demand. They are cost-saving if they raise output with a given input. They will not be adopted, however, unless the expected reduction of costs justifies them, that is, there is a chance for greater profits.

Innovations originating on the demand side may raise both costs and prices. These are generally adopted to increase or maintain a share of the market. Many convenience innovations involve new or altered goods. If they appear able to produce higher returns per dollar of input, someone promotes them. Product changes are important levers in the competitive struggle for firm survival.

It seems clear that innovations play a vital role in our economy. They affect the structure of our industry. As succeeding innovations jar our economy, changes and adjustments occur. A smooth absorption of change in a growing economy depends on the mobility of labor and fluidity of capital. Orderly development of innovations can offer new opportunities for investment before the effects of the old run out. This smoothes the cyclical growth pattern. Increasingly, investments by Government and industry in research and development programs help reduce the sporadic nature of major innovations.

CONDITIONS UNDER WHICH INNOVATIONS APPEAR

The environmental fabric of our economy enables innovations to flourish. The texture is an intertwining of individual initiative, an expanding population gainfully employed, and a rapidly rising growth in income. The natural curiosity of men, coupled with dynamic scientific systems, continuously weaves strong new threads into the material of progress.

Innovations appear more frequently in some countries than in others. This leads us to believe that some environmental or cultural conditions promote adoption of new ideas and that other conditions curtail or discourage them. One important condition favoring creation and adoption of innovations is freedom of individual action. A system that allows any person or firm to market any product, provided it meets accepted health and sanitation standards, promotes innovations.

The expectation of profits accruing to the innovator encourages him--even if failure is a distinct possibility.

A wide variety of other factors may affect the rate at which innovations appear. One of these is a general attitude of looking with favor on newness or differentness. Another is the amount of research and development in progress. A most important factor affecting new food products is a mass market which is able to absorb a large variety of new items. Another climatic factor is the general monetary and fiscal policy of the Government. Still another is the general level of business activity.

Competition and Monopoly

Competition appears to encourage creation of innovations. On the supply side, it helps keep costs at the lowest possible levels. On the demand side, it encourages firms to introduce new and different products. It leads to changes in structure and pricing policy, as firms seek to gain advantage over their rivals in the market.

If a firm does not innovate, it faces the possibility of having its cost structure or its product line become obsolete. In these cases it may lose its competitive position and even go bankrupt. The expression "innovate or perish" is not an idle jest. In many industries, innovation is the heartbeat that keeps the firms alive and healthy.

But, under certain conditions, firms may go slow in adopting available innovations. Because competitors are quick to adopt and copy an innovation, the time lag between the introduction and the copying of it determines amount of profits. This explains somewhat why some firms are reluctant to innovate without exclusive patent rights. If there were a greater time lag between when an innovation is introduced and when it is copied, it is possible that more innovations would be developed. Since monopoly and oligopoly do extend this time lag, it could be argued that a monopoly firm might be more inclined to innovate than firms in a highly competitive industry. The purpose of patents is to give monopoly use of new ideas during a limited time.

Population Changes

Marketing innovations occur more naturally and easily in a changing economy than in a static one. Thus, changes in the size or composition of the population may affect the rate of innovation.

In 1930 our population numbered 123 million, and by January 1965 it totaled 193 million. This was an increase of about 1.3 percent per year, or a net addition averaging about 2 million persons per year. Our net rate of increase now is 7,200 persons per day. An expanding population encourages development of new products and processes, and varying forms of structural organizations.

But, although a growing population may be important to the development of innovations, it is not an inevitable cause. Otherwise, many underdeveloped but densely populated areas would experience a great push for innovations. Some countries have been slow in accepting new ways, ideas, and improvements. Lack of progress in underdeveloped countries is a result of low incomes, illiteracy, low education levels, and many other factors. A high regard for the past, prevalent in some cultures, is of great importance in inhibiting acceptance of innovations. An innovational climate may be described as one containing people curious as to the future without having an overbalancing commitment to their past.

Within our population certain changes are evident. We are less rural and more a nation of city dwellers. We live less in houses and more in apartments. In 1950, 41 percent of our people lived in cities. By 1960, the percentage of city dwellers had increased to 44 percent (table 1). City people have more sedentary work and this affects their eating habits, which in turn affects marketing practices.

Our population is simultaneously becoming older and younger. Percentages of persons 65 or over and of youngsters 14 or younger were both higher in 1960 than in 1930. These two groups need and prefer more bland foods than other age groups. Both are more likely to want and use convenience foods. Both differ from the other age groups in their clothing and recreation needs.

Working Force

Over the years, our civilian working force has stayed fairly constant at 38 to 42 percent of the population. However, more women than before, particularly married women, now work. Probably the working women replace older men who may now retire at an earlier age. Also, many young men can stay in school longer and do not have to join the work force at such an early age. In 1940, working women constituted 26 percent of the civilian labor force. By 1965, the proportion was 35 percent.

Today's working housewives have neither the time nor, in some cases, the inclination to spend much effort cooking. Because of their other responsibilities, they wish to be freed from the bondage of the kitchen. Or is it that because they wish to be free of the kitchen they seek jobs outside the home? In the past, they achieved this kitchen freedom by use of servants or through engaging in social and community activities. They now buy prepared mixes, precooked meals, frozen foods, canned foods, and other convenience items in increasing quantities. Twenty-six million working women create a tremendous market outlet for convenience foods. They have found that a number of convenience foods cost no more than the home-prepared form (13, 25). Of course, many home-prepared items are lower in cost.

Income of Consumers

An important demand factor influencing acceptance of innovation is consumer income. The higher the income of an individual, the more likely he is to try new products. Conversely, the lower a consumer's income, the less likely he is to try new

Table 1.--Population and labor force of the United States, 1930-65

Item	Units	January-- 1930	1940	1950	1960	1965 1/
Total civilian population Jan. 1 2/	Mil.	122.5	131.5	150.6	179.4	192.8
Persons living in cities of 25,000 or more people 3/	Mil.	49.4	52.9	62.3	79.8	n.a.
Persons living in cities of 25,000 or more people as percentage of population	Pct.	40	40	41	44	n.a.
Persons 65 or over 4/	Mil.	6.6	9.0	12.3	16.6	n.a.
Persons 65 or over as percentage of population	Pct.	5	7	8	9	n.a.
Children 14 or under 5/	Mil.	36.2	33.1	40.7	55.8	n.a.
Children 14 or under as percentage of total	Pct.	30	25.	27	31	n.a.
Total civilian labor force 5/	Mil.	6/48.6	6/55.6	6/63.1	70.6	73.0
Labor force as percentage of population	Pct.	41	42	42	39	38
Women in civilian labor force 5/	Mil.	10.7	6/14.2	6/18.7	23.6	25.5
Working women as percentage of civilian labor force	Pct.	n.a.	26	30	33	35

1/ Preliminary. 2/ (28, 32). 3/ (29). 4/ (30). 5/ (31).
6/ Does not include Alaska and Hawaii.

and different commodities. Incomes in the United States are much higher now than they have been in the past, and this helps provide a favorable climate for introduction of innovations.

Total disposable personal income in the United States was $74 billion in 1929 and $465 billion in 1965 (table 2). Per capita income was $625 in 1929 and by 1965 was $2,391. Even when adjusted for change in prices, 1965 per capita income was twice that of 1929.

Viewing the economy as a whole, incomes depend upon many factors, one of which is innovation itself. Thus, it might be said that innovation leads to innovation.

Education

Education contributes to scientific and technological progress and also to the general quality of the labor force. One study, for example, found that two-fifths of the 56-percent increase in worker productivity that took place in a 28-year period could be attributed to increases in formal education (7).

Education may influence innovations and productivity indirectly. Highly educated administrators improve organization and operations. Educated engineers and businessmen see the need for innovations and put them into practice.

Education, incomes, and innovations mutually reinforce each other. Innovations provide higher incomes. High incomes allow young people to stay in school longer and make it easier for experienced workers to attain further education or training. Through increased knowledge and skills, these workers then contribute to further innovations.

Table 2.--Income of persons in the United States, 1930-65

Income	Units	1930	1940	1950	1960	1965
Total personal disposable	Bil. dol.	74.4	76.1	207.7	349.9	465.3
Per capita	Dol.	625	596	1,506	2,221	2,391
Consumer prices index	1957-59 = 100	58	49	84	103	109.9
Per capita income adjusted for prices	do.	100	113	166	200	201

Source: (33).

Closely related to the rising educational level of the population and hence to productivity gains is the increase in total expenditures for education in the United States. Expenditures for education as a percentage of national income dropped considerably during the depression and war years of the 1930's and 1940's, but have climbed steadily throughout the postwar period. In 1962, 7 percent of the national income was devoted to education, compared with 4.7 percent in 1929.

Leisure and Workers: A Complex Relation

Workers' recreation is important in our present society. Innovations in industry shorten the work week. The 40-hour week of today replaces the 48-hour week of a few years ago. This, in turn, may give way to a 35- or 36-hour week in future years. More paid vacations supplement shorter weeks and both allow more leisure time for workers. Thus, innovations directly affect the amount of worker leisure time.

Workers in all industries vie with each other for fringe benefits of all types. Fringe benefits raise labor costs, and their introduction places a premium on ways of cutting costs or raising volumes. As labor costs rise relative to other costs, a businessman has more incentive to innovate, especially to substitute machines for men.

On the other side of the coin, as workers have more leisure time they take up new hobbies, sports, and games. Dozens of gadgets supply the do-it-yourself workshop. Mechanized garden and lawn tools are commonplace in suburban areas. Sports, recreation, and other activities put the leisure-time industry on a new footing. These items alone or by themselves are not innovations. What is new and important about them is that they now come on the market in multiplied volume. In total, these tools, appliances, gadgets, and toys are important users of investment, labor, and management. The new way of living they produce is an innovation. Thus, leisure time, which is partly a result of innovations, also encourages innovations in a leisure industry that now is an important segment of our economy.

Changes in Consumption Patterns

The previous paragraphs were concerned with factors that provide a favorable climate for the introduction of innovations. These climatic factors operate indirectly, by stimulating changes that are more direct causes of innovation. Here, we discuss some of these intermediate factors, including changes in per capita consumption, and in demand for convenience foods.

Table 3 shows three groups of representative foods that have had substantial decreases, little change, or increases in per capita consumption during the last few decades. This does not give a complete picture, but portrays the type of changes occurring (table 3).

Food consumption patterns change as times change. Population growth and increases in real income are important causes of change in food consumption patterns. For example, recent increases in consumption of beef and ice cream probably result from increased consumer income. Other important factors that influence food consumption are occupational changes, rural to urban population movements, and changes in working population. Increasing attention to diet as a health factor accentuates interest in foods low in calories and fats. A new product may replace another if it performs a particular function better, or if it costs less.

Changes in Methods of Processing Foods

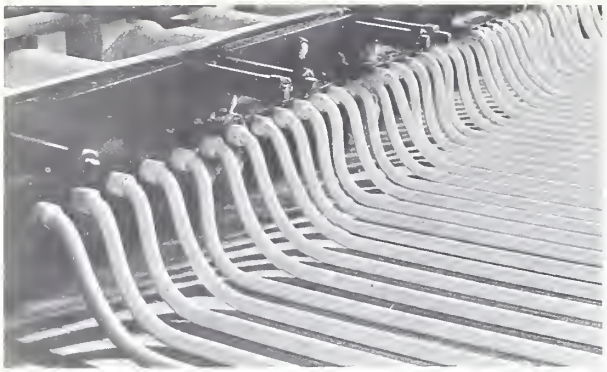
Many of the new and different foods consumed today are the result of new methods of processing. Thus, technological developments in processing bring about changed eating habits. In table 4 we show changes in per capita consumption of fruits and vegetables processed by various methods. Per capita consumption of both fresh and dried fruits has been declining since 1939. During the same period, consumption of canned and frozen fruits and juices has increased. Although total consumption of fruits in all forms has stayed about constant from 1929 to 1965, there are great changes taking place in the way we eat these fruits. The main change has been a substitution of canned and frozen fruits and juices for fresh fruits. In addition to changes occurring in the methods of processing, handling, shipping, and selling our fruits, we consume different kinds than formerly. For example, we eat more oranges and fewer apples. Also, we eat more of our fruits on a year-round basis rather then just in season. This has come about partly as a result of the change from fresh to processed fruits, partly because of technological advancements in storage of fresh fruits, and partly as a reflection of the shifts taking place in growing areas. A higher percentage of our fruits now are grown in the South and Southwest.

Total consumption per capita of all vegetables, other than potatoes, increased from 139 pounds in 1929 to 160 pounds in 1965. Per capita consumption of fresh potatoes and sweetpotatoes declined from 1929 to 1959, but now seems to have leveled off.

The increasing popularity of foods processed by the newer methods has benefited processors of certain farm foods and lost markets for others. In general, consumers have benefited. They have a wider selection of foods available to them in that they have all or most of the foods they previously had plus a whole range of new ones. They now have foods similar to the fresh ones available in all seasons. Many of the processed foods cost less than the comparable fresh ones.

INNOVATIONS IN AGRICULTURAL MARKETING

Most innovations in the marketing of farm products are adaptations of innovations from other economic sectors, particularly from other industries. Important recent innovations have been in the fields of materials-handling, communications, transportation, and business procedures. Introduction of new products is important. Structural changes are taking place in the marketing system, and the resulting larger scale of operation lowers costs. Consolidation of firms often alters merchandising, purchasing, and pricing methods.



Pretzel dough is extruded from dies made of material that will not stick to the hard-to-handle bakery product.

Automatic equipment forms, fills, and seals pouches at the rate of one per second. Pictured here are the new boil-in-the-bag products that are becoming available in increasing numbers. These use sauces that do not separate on freezing--a development of USDA's Western Utilization Laboratory.

Weighing and filling device measures liquid eggs into sanitary plastic bags, to be sealed and frozen at -10 to -20°F.

Tempeh, an Indonesian food made by wrapping dehulled, cooked soybeans in banana leaves, is innoculated with a culture and fermented. Pictured here is a modern Tempeh in a perforated plastic bag, fermented with fungus Rhizopus 24 hours at 85°F--process developed at USDA's Northern Utilization Laboratory. Tempeh may become an important source of plant-derived protein in the future.

Table 3.--Per capita consumption of major farm products, United States, selected years, 1929-65

Product and group	1929	1939	1949	1959	1965 1/
			-Pounds-		
Decreased consumption:					
Potatoes, except canned and frozen, farm weight	159	122	110	101	89
Citrus fruit, fresh	40	61	48	33	29
Apples, fresh	40	31	25	23	20
Lard	13	13	12	9	6
Wheat, flour	177	158	136	120	116
Cotton	28	28	26	24	23
Butter	18	17	10	8	6
Little change in consumption:					
Dry beans	8	9	7	8	7
Pork, no offal or lard, carcass weight	70	65	68	68	59
Eggs	42	39	49	46	40
Sugar	97	101	96	96	96
Whole milk, fluid	272	266	296	292	270
Rice, milled	6	6	5	5	8
Wool	3	3	3	2	3
Increased consumption:					
Beef, no offal, carcass weight	50	55	64	81	99
Shortening, other than lard and margarine	10	11	10	13	14
Chickens, ready to cook	14	14	20	29	33
Nonfat dry milk	1	2	3	6	6
Ice cream	11	11	18	19	18
Margarine	3	2	6	9	10
Canned soup	4	6	10	15	16

1/ Preliminary.

Source: (11, 12, 15).

A Closer Look at Farm-Product Marketing Innovations

In the past several decades, we have had a flow of farm marketing changes that challenges the imagination. Present-day supermarkets handle 6,000 to 8,000 or more different items. Many of these were not even in existence a decade ago. Many on the shelves today will be missing next year, replaced by still other new products.

The technological revolution of the food industry is such that a substantial proportion of sales of most of the larger food processing companies are from new products developed within the last 5 years. Some changes in products and in methods are so slight as to be hardly distinguishable. A few, however, are revolutionary.

Innovations has been a major factor in the trends in marketing farm products. Cash receipts from farm marketings increased from $11 to $37 billion in the last

Table 4.--A comparison of per capita consumption of fresh and processed fruits and vegetables, United States, selected years, 1929-65

Processing method	1929	1939	1949	1959	1965 1/
	-Pounds-				
FRUITS					
Fresh, farm weight	139	148	123	97	84
Canned fruit	12	16	20	22	24
Canned fruit juices	---	6	15	13	13
Dried	5	6	4	3	3
Frozen fruit and juices, citrus and noncitrus, on a single-strength basis	1	1	6	20	21
Total fruit (single strength)	157	177	168	155	145
VEGETABLES					
Fresh, not including potatoes and sweetpotatoes (farm weight basis)	113	117	116	103	101
Fresh potatoes and sweetpotatoes (farm weight basis)	182	142	122	110	111
Canned, including potatoes	26	32	39	45	47
Frozen, not including potatoes	0	1	3	7	7
Frozen potatoes	---	---	---	2	5
Total vegetables, not including fresh potatoes or sweetpotatoes	139	150	158	157	160
Total vegetables, including fresh potatoes and sweetpotatoes	321	292	280	267	271

1/ Includes Hawaii and Alaska. Preliminary.

Sources: (10, 15).

34-year period. In this same period, man-hours used in processing farm-produced foods increased only slightly (table 5). Productivity, as measured by output per man-hour, more than doubled.

How does growth in food manufacturing compare with growth of other industries? Waldorf shows that annual growth rate in food manufacturing was about the same as in manufacturing of nonfood products (36). Productivity gains in food manufacturing have appeared as fixed capital savings as well as labor savings. There has been a definite upgrading of labor, and jobs requiring skilled workers now make up a larger share of the total jobs.

New and Improved Foods and Fibers

In recent years, food innovations have accentuated convenience. Until recently, convenience meant "built-in-maid service." Now it has added the dimension of "built-in chef service." This means that different and higher quality foods now are available that are better than the average housewife can prepare. Whole dinners, entrees, and salads are tailored for home or institutional serving. Boil-in-the-bag foods, prepared potato products, soluble coffee and instant puddings, frozen baked

Table 5.--Processing farm food products: Production and efficiency, United States, 1929-1963

(Index, 1947-49 = 100)

Item	1929	1939	1949	1959	1963
Physical output of firms processing farm food products	65	72	100	131	145
Number of man-hours	92	78	99	96	93
Physical output per man-hour	71	92	101	137	156

Source: (36).

goods, brown-and-serve rolls, ready-to-bake bread, sour cream, and yogurt--these are all timesaving products. Dehydrated soups, with their ingredients dried by different processes and combined into one package, point to a trend in greater use of dried foods. Dried mixes and freeze-dried fruits and berries in breakfast cereals are other examples of foods of the future.

Packages of meat are cut, wrapped, weighed, and priced before being put on display in the market. Fowl can be bought stuffed, barbecued, or in steaks and rolls. Exotic foods and newly popular foods with previously low-volume sales are innovations in the sense that they are new to, and make an impact on, the mass market.

Successful food innovations develop rapidly. Figure 1 shows the rapid growth in production of seven groups of frozen food items. The growth in production of soluble coffee and processed potatoes is shown in figure 2. Note high rate of growth of frozen poultry and frozen concentrates.

The growth in production of soluble coffee and processed potato products has come about since 1950. In general, a successful new product increases its volume by 50 to 60 percent each year during its first 5 years of commercialization. Each year of the next 5-year period adds from 25 to 30 percent to the previous year's volume (5).

Durable press and stretch fiber technology extended to cotton fabrics may slow the trend towards loss of markets to synthetic fibers. Researchers have now removed shrinkability from wool. This new wool is now on a more equal footing with synthetic fibers since it still retains its natural desirable characteristics. The Department's WURLAN process permits easy laundering of wool in the home.

Over a long period, cotton and wool have been holding their own in terms of per capita usage, but have been losing in their share of new-market penetration. U.S. cotton and wool consumption per capita has stayed at about 25 pounds per person for the last 30 years (table 6). In the same period, however, fibers other than cotton and wool increased from 2 to 14 pounds per capita. Thirty years ago cotton and wool had 92 percent of the market, but this has declined to 64 percent. Use of manmade fibers has raised total consumption of fibers from 27 to 39 pounds per person.

A Special Case: Farm Products in the Industrial Market

Farm products have been used in industry for many years. Oils of various seeds, byproducts of the slaughter industry, and starch from corn are important. Various

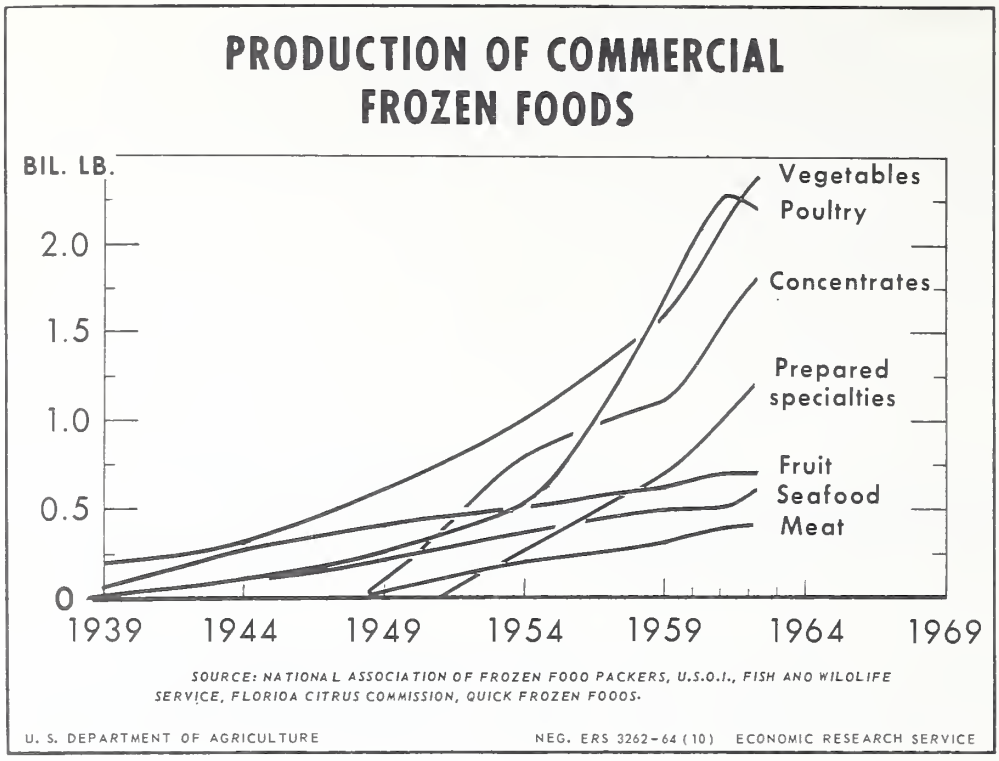


Figure 1

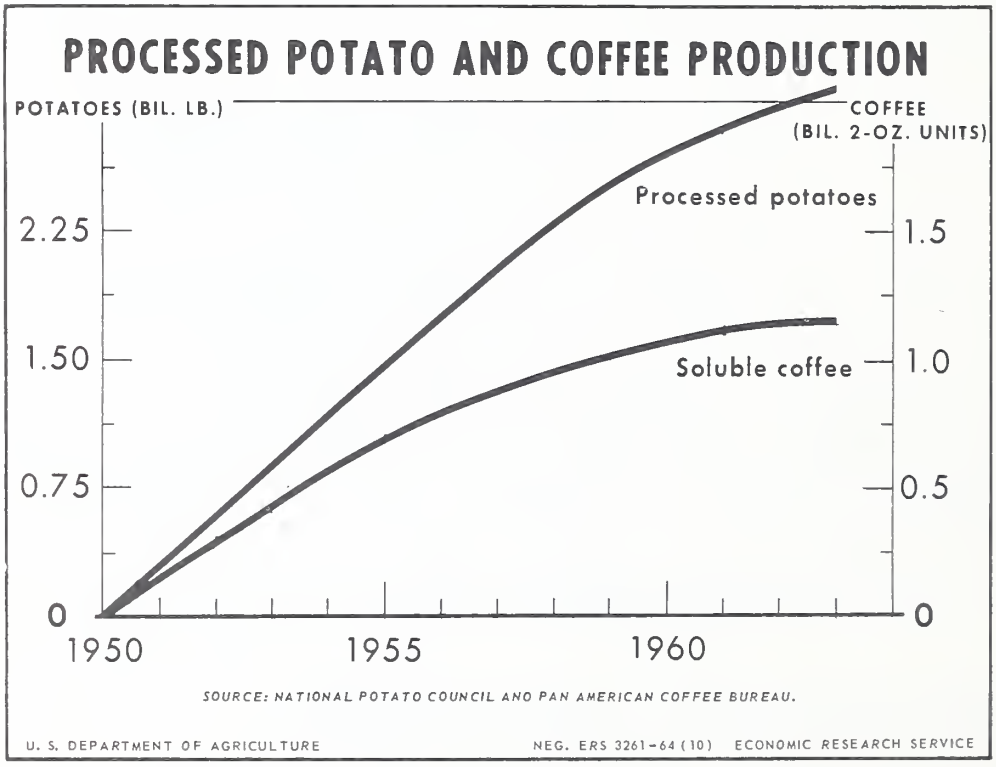


Figure 2

Table 6.--Domestic consumption of fibers, United States, selected years, 1935-64

Year	Cotton and wool			Manmade fibers		
	Total	Per Capita	Percentage of all fibers	Total	Per Capita	Percentage of all fibers
	Billion pounds	Pounds	Percent	Billion pounds	Pounds	Percent
1935.....	3.1	25	92	0.3	2	8
1949.....	4.0	27	80	1.0	7	20
1964.....	4.7	25	64	2.7	14	36

Source: (8, 9).

dairy byproducts go to this market. A major problem is that many farm products going to industrial users may be duplicated with nonagricultural source materials, hence, innovations in industry have severely limited this market for farm products. Most nonagricultural substitutes are less costly or have technical capabilities for specific uses. Petroleum and mineral substitutes have caused linseed oil sales volume to drop almost one-fourth in 10 years. Synthetic paints offer advantages in colors, application, and durability which take other markets away from linseed oil. Plastic laminates have captured some of the cotton market. Glass fibers have gained new markets, and plastic boats come equipped with nylon or polyester sails.

On the other hand, innovations in farm raw materials have checked inroads made by some synthetics into the market for farm products. Research of the utilization laboratories of the Department of Agriculture has been effective. When animal fats were losing their traditional markets in soap, laboratory and market research found a new market for fats in feeds. This particular use now absorbs 800 million pounds of fats annually. The utilization laboratories also have found new uses for fats and oils as plasticizers. Researchers are finding new uses for gums, starches, and proteins. Wash-and-wear cottons have been of significance in the fiber markets.

Changes in Food-Processing Methods

There has been a continual series of innovations in food processing. Ever since our cavemen ancestors learned that meat or fish would be edible after hanging in the sun for a few days, we have been improving existing food-processing methods. In addition, we have discovered entirely new processing methods. Our food-processing know-how is now one of our most valuable national assets.

Canning

Canning, our largest volume food-processing industry, began in the early 1800's, when Napoleon offered a reward to anyone who could develop a new food-processing method that would be useful in feeding his armies. Major changes have come about since then.

The present U.S. canning industry comprises about 2,200 canneries which produce about 1,200 different canned food items with an annual volume exceeding 21 billion pounds. This contrasts with 10 years ago, when we canned only 550 different foods.

The 1963 pack of canned foods was approximately 760 million cases holding over 26 billion containers.

In the past decade, canners have made increasing use of an innovation called high temperature, short time (HTST) preservation. In aseptic canning, another new process, the product and can are sterilized independently. This not only maintains quality, but allows lower costs. Hydrostatic preservation has been used in Europe for some years but is a recent canning innovation in the United States. The filled cans or bottles move up and down through towers which control pressure and heat. This continuous system saves steam, cooling water, and floor space. In still another method, dehydrocanning, processors remove about half of the moisture from the food before canning the product.

Innovations, such as the use of aluminum and the zip-top, pop-open-top, and thin-tin cans, continually change the can market and keep it in a state of transition.

Frozen Foods

The frozen-food industry, developed almost entirely since World War II, now produces an annual volume of over 10 billion pounds. Vegetables, poultry, concentrates, and prepared items have had the greatest recent growth (table 7).

In 1963, a survey of use of frozen foods in 26 U.S. cities showed that 59 percent of families bought frozen vegetables (18). Comparable figures for some other frozen foods were orange juice concentrate, 57 percent; poultry pies, 66 percent; dessert pies, 30 percent; eviscerated poultry, 36 percent; dinners, 27 percent; and fish sticks, 19 percent. Since most of these foods were not available in frozen form two decades earlier, these percentages show that frozen foods have had far-reaching effects on food marketing, processing, and production.

Fluidized-bed freezing cuts down on freezing time for products such as green peas, beans, corn, and diced potatoes. It reduces investment, processing costs, and floor space requirements. Another important marketing innovation is the recent introduction of partly or completely prepared frozen items. Since these foods incorporate preparation, convenience, and "chef service," they improve the competitive position of the freezing industry. Boil-in-the-bag foods are an example. Processors add cream, white, butter, or other sauces before sealing the bag and freezing the food. This concept may be a major breakthrough in frozen food convenience. Other newly developed frozen prepared items are breaded onion rings, breaded fish sticks, eggrolls, and frozen baked goods. At present, some hospitals and schools are testing portion-controlled, factory-prepared meals. Many of these, if the idea is successful, will be frozen.

Dehydrofrozen fruits and vegetables have made some gains in recent years. Apple slices for pie baking have had the most notable success, and seven companies now produce them. Success with dehydrofrozen green peas has been disappointing to date, but potatoes, cherries, and carrots may have a brighter future.

Another innovation in the freezing industry is low-temperature freezing. This is truly "quick" freezing, for nitrogen is used and temperatures range downward to 320° F. below zero. Processing costs currently are high, but the method allows freezing of such products as melons, mushrooms, avocados, and seafood difficult to handle under ordinary freezing conditions. If the price of nitrogen falls below its present level of 3 to 4 cents per pound, the process may be adapted to an even

Table 7.--Production of commercial frozen foods, United States, selected years, 1939-63

Year	All noncitrus fruit, juices, and berries	All vegetables except potatoes	Potato products	Poultry	Meats	Seafood 1/	Prepared specialities	Concentrates on a single-strength basis 2/	Total of previous columns
				Million Pounds					
1939.	141	71	0	15	10	30	---	---	287
1944.	338	237	0	90	20	53	10	---	785
1949.	359	541	16	200	27	97	60	140	1,508
1954.	523	881	85	525	212	267	219	783	3,678
1959.	618	1,250	371	1,747	310	---	790	1,096	6,660
1963.	619	1,452	862	1,733	360	676	1,065	2,103	8,609

1/ Figures for the years 1939 through 1962 are on a live weight basis, but 1963 is an estimate of product weight. Thus, the years are not comparable.

2/ Concentrate figures include frozen concentrates of the following: Orange juice, 54 mil. gal.; grapefruit juice, 2.6 mil. gal.; blend, 0.2 mil. gal.; tangerine juice, 0.1 mil. gal.; and lemon juice, 2.6 mil. gal. These citrus juices totaled 60 mil. gal. of concentrated juice in 1963. Frozen concentrated fruit drinks are not included; they are estimated at 989 million pounds for 1963. Noncitrus juices totaled 11 mil. gal. in 1963. Figures for 1939 through 1963 do not include noncitrus juices. All figures for concentrates have been converted to single-strength basis by multiplying number of gallons by 34.9.

Sources: Cols. 1-3 (33), col. 7 (17). Cols. 4-6 and col. 8, unpublished data from the National Association of Frozen Food Packers, Washington, D.C., and the Florida Citrus Commission, Lakeland, Fla., respectively.

wider range of foods. At present, several companies are trying the process on a commercial basis.

The use of nitrogen in the refrigerated-truck transportation of frozen foods is becoming popular. It offers low investment in refrigeration equipment, although operating costs are higher than for comparable mechanical compressor units. At present nitrogen price levels, it is not practical to cool refrigerated trucks with nitrogen--only to keep frozen food which is already at desired temperature levels.

Individually quickfrozen items provide free-flow frozen fruits and vegetables such as strawberries, peas, and corn. Advantages to the consumer are ease of handling, more easily adjusted portion control, faster thawing and cooking, and, possibly, less quality loss through oxidation. Many new techniques, including use of microwaves, are now being adapted to use in the thawing of frozen foods, particularly in the food service industry.

Dehydration

The primary advances in dehydration include new methods of heat injection and water removal, and improvements in packaging. Continuous belt tunnel driers replace older atmospheric tunnel driers. Fluidized-bed drying of vegetables has become important. Drum drying has recently been adapted for drying sweetpotatoes, pumpkins, and applesauce.

Vacuum drying of whole milk powder may be a major innovation for the dairy industry. Currently, foam-mat drying, another USDA innovation, is being applied to citrus, tomato, and other juices. No products are yet in the commercial market.

Food preservation by freeze-drying had its early commercial beginnings in the late fifties, but did not become economically practical until recently, as newer methods of applying heat and removing water lowered costs. Now 50 or 60 products are on the market. Volume of freeze-dried foods in 1964 was about 25 million pounds, wet weight. In 1965, volume was about 50 million pounds. In 1970, it may be 350 to 500 million pounds. Although an expensive method for preserving most foods, freeze-drying is applicable to specialty items and ingredients when a high-quality dried food is needed. Innovations, especially those lowering costs, will allow the new processing method to be used on more foods for more uses. Some of the latest applications of freeze-drying in the food field are to coffee, berries and fruits for cereals, and ice cream.

An interesting processing development is the short-time evaporator which dries food at high temperatures in a short time--as few as 55 to 60 seconds. The compressor-evaporator is used primarily for skim milk and ice cream mix. Its advantage is in labor-cost savings. Still another evaporator is the heat pump, used in processing of dairy products.

In fruit juice concentration and drying, an innovation with USDA's label is essence-recovery. Although it was developed in the early fifties, the method has recently become important in jams and jellies. It allows recovery of vital juice essences usually lost in dehydration and provides food processors with a natural flavor component to enhance the quality of many processed fruit products. It may also be used for purposes such as recapturing delicate odors lost in drying coffee or shellfish.

A dehydration innovation still in the development stage is centrifuging. It is used experimentally for beer and vinegar, but may have use for other liquids. One

procedure is to slush-freeze the product and then centrifuge it to separate the ice-crystal bed.

Explosive-puffing, long used in the preparing of grains for the breakfast cereal industry, is now an innovation in fruit, berry, and vegetable drying. Diced carrots and beets, sliced apples, and blueberries are among the newer explosive-puffed dried foods, and driers now market several of them.

Reverse osmosis is a new dehydration method that offers future promise. It is a simple operation: Fluids may be extracted from foods in exactly the reverse process to the one in which they enter foods.

Other Processing Methods

Irradiation has been discussed as a new processing method for years. Within the last 2 years, the U.S. Food and Drug Administration approved cured bacon, potatoes, and wheat for radiation processing, and the U.S. Army is now submitting bids for procurement of these items. Radiation may be used in high-level treatments to sterilize (destroy all bacteria). Or a milder or pasteurization treatment may be used to reduce the number of bacteria. Radiation is also used for sprout inhibition and to kill insects or larvae. Still another use is to extend shelf life of fresh, frozen, and canned foods. Fresh fish, for example, may have its shelf life extended by 12 to 24 days.

The adoption of the superpower tube, which generates microwave power that is 100 times greater than that normally used for microwave cooking, will require co-operation and a mutual educational program between scientists and food processors. The tube's high power output--plus the unique characteristics of microwave energy--will determine exactly where and how this energy may be applied to food processing, and the device may become an innovation in this field in years ahead.

An important effect of changes in food processing may be to change location of crop and livestock production. Food dehydration, for example, may give the Pacific Coast and other far-from-market States a greater advantage in fruit and vegetable production. These are areas where irrigation, level land, and large-scale operations lower production costs. Dehydration lowers shipping costs and allows lower total costs than for close-to-market areas.

Innovations in Food Handling

Food equipment companies have developed new machines for handling food. Water flumes handle potatoes, vegetables, and some fruits. Pneumatic tubes move foods that are particulate and finely ground. Augers are used for a variety of foods. Pipes handle sirups, honey, fruits, vegetable juices, milk, and other liquid or miscible solids. Advances in pump development accelerate use of this method. These methods are innovations in the sense that they are progressively improved and used in the food industry.

In handling fruits and vegetables and some other products, the bulk box holding 1,000 to 2,000 pounds is now in general use. These containers are handled by fork-trucks. Automatic dumping machines unload these specially designed boxes.

Trucks and trailers of all descriptions are used for field and road hauling of farm products. Some have built-in unloading conveyors; others have special dump

beds. Dumping may be done from the front, rear, or sides, depending on the product and the convenience of the operator. Hauling units are now more specialized, expensive, and efficient, but yield lower per-unit costs since they release more than an equivalent amount of labor. Grain elevators and flour mills unload whole railroad cars by picking them up and dumping their contents.

Sound waves shake and settle contents of containers. This packing process minimizes headspace and in some instances may allow smaller packages. Automatic checkweighers are now in common use. Ultraviolet lights, irradiation, chlorine in water, and improved cleansing detergents help keep processing and handling operations clean.

Various mechanical devices now automatically wash, size, grade, and pack eggs. Other machines pluck and eviscerate chickens. Automatic bacon and luncheon-meat slicers and deboners are cost-cutting innovations. Firms handling fruits, vegetables, and other foods use similar techniques.

Innovations in Food Packages and Containers

Innovations in food packaging are closely associated with those of food processing. Neither could have developed to its present high level of usefulness without the other.

Metal Containers

The can, our most important food container, has been changed radically in recent years. The tab-pull opener, pull-strip, and plastic lid have replaced the key-type opener; the lids of some cans are held on by vacuum.

Aluminum cans may be extruded, and production speed of the new equipment is 10 times greater than for the usual tin cans. Some aluminum cans may be used as cooking vessels after opening. Other aluminum containers, such as those used for TV dinners and frozen baked goods, serve not only as cooking, baking, and serving dishes, but as shipping and merchandising vessels as well. Meanwhile, manufacturers of tin cans are developing new lightweight steel cans.

Paper and Board Containers

Use of paper and board containers is increasing as this type of package is improved. Disposable salt and pepper shakers made of paper are now common. A paper can for ready-to-bake rolls tears apart exposing each roll as it opens. Some new papers used in these cans are waterproof.

Paper and fiberboard may be combined with other container materials such as aluminum foil, cellophane, and polyethylene. Outer boxes of paper may be used with plastic inner liners--the boil-in-the-bag container is a recent example. Paper and other materials may be bonded or laminated together. One cost-cutting innovation is a can made from paper or cardboard with steel or aluminum top and bottom. This is already in general use for some industrial products such as motor oils, and is beginning to be used for frozen fruits and juices. A large fiberboard box, developed for bulk shipments of farm products, holds 600 to 1,400 pounds. After use, the boxes are folded and shipped for reuse. Pallet slings made of paper have come into general use for handling sacked products of beans, peas, sugar, and other products. These bulk containers allow shipping and handling cost reductions.

Food pouches made of laminated combinations of plastic paper and foil are so new that their marketing impact is still being assessed. The increasing use of such pouches for instant coffee, sugar, powdered milk, and tea can be attested to by travelers who now find them in motels and on planes. Laminated plastic containers for preserves, catsup, mustard, and many other foods also are common. Bottles are now made of plastic. Makers of glass bottles market disposable beer and soft drink bottles. A new plastic display tray for salads, vegetables, and other items now is being used in delicatessen stores.

Milk-packaging changes include the tetrapack paper container. This package, together with its attendant carton-forming equipment, created a stir in the dairy industry several years ago. The packaging machine, reputed to make 70 boxes per minute, has had great success in western Europe. The cardboard packaging of water is a product innovation of dairy plants. The water, sterilized and marketed like milk, is in limited demand for use in storm cellars and bomb shelters.

Flexible Films

Flexible films have an important role in marketing of agricultural products. Cellophane, an innovation in the middle twenties, allowed prepackaging of fresh meats by 1946. Development of this and similar packaging materials allowed and encouraged changes in retailing and wholesaling procedures. The other packaging films became competitors of and companion products to cellophane. Polyethylene, polypropylene, ploystyrene, and vinyl films have varying degrees of strength, shrinkability, and heat resistance, which give them a diversity of uses.

Self-adhering films are now common for kitchen use. They are limp and especially useful in overwrapping. When used for packaging hot food they shrink along with the food and provide a tight-fitting package. Kitchen utensils with stick-proof coating (a byproduct of the Air Force Space Program) are popular with restaurants and homeowners alike (23). Development of edible film coatings for food is still in the laboratory stage.

Equal advances have been made in container-filling equipment. There are machines for overwrapping, shrink wrapping, can filling, sack filling, and carton filling. As new kinds of packages are developed, new machines are developed to fill them.

Innovations in Food Selling

Firms handling agricultural products have been going through changes in ownership and control. Previously, wholesale firms in the food industry were the focal point for pricing. Wholesalers were "in-between men" who received price commands and responses from the demand side (retailer) and the supply side (processor or packer). Now, the pricing role of the wholesaler is decreasing; retailers have been assuming middleman functions. This change comes partly as a result of development of the supermarket, and partly as a result of growth in size of retail chainstores.

Integrated chains find that by buying directly from packers and processors they have advantages in price, quality, standards, and uniformity. Some retailers develop a "company label" to compete with nationally advertised brand items. Retailer brands generally sell for less since the retailer has been able to bypass development and promotion expense.

A revolutionary change taking place at the retailing and wholesaling levels is the transfer of functions. Several decades ago retail clerks performed all the duties in a grocery store. A few years ago clerks did most of the packaging, weighing, and pricing, but often did not wait on customers. Present-day modern chain stores are moving more and more of these retail chores to a central distribution location where they may be done more efficiently.

There are a number of advantages in centralizing these many functions. Labor efficiency in distribution centers improves as workers become specialized. As volumes become larger, wholesalers can better utilize machines and laborsaving devices. Larger volumes also will encourage development of more modern equipment. At the store level, merchandising can be more effective and personalized as clerks are released from pricing, stocking shelves, and packing. Inventory management can be improved, and more control can be exercised for quality standards. Land and building costs are cheaper in the centralized locations than in retail locations. Total costs of food distribution are lower. Stores making these innovations in retailing and wholesaling are able to compete more successfully.

The self-service idea in food retailing is not new, but today's ultramodern supermarket is much different from the self-service stores of the 1920's. Today's supermarket embodies many innovations. For example, packaged items expedite self-service. The modern store has streamlined checkout stands, improved lighting, air conditioning, adequate parking, and background music. Conveyors and fork-trucks handle goods brought into the store. Behind-the-wall stocking of shelves is becoming important. Computers assist in inventory control and purchasing.

Counterbalancing the trend towards larger scale supermarkets is the one toward small neighborhood retail outlets. Generally, these stores are multiunit. In the United States there are now 37 convenience-store chains comprised of 10 or more units, the largest chain having more than 1,200 stores. In total, there are over 5,000 convenience outlets in operation, with annual sales of over $1 billion. Usually, they carry national-brand merchandise, normally limited to fast-moving brands and sizes. In general, stores of this type carry from 1,500 to 3,000 items.

A structural innovation within grocery stores is the increasing proportion of sales of nonfood items. Grocery stores handling drugs, hardware, clothing, appliances, and auto supplies are returning to the old country-store idea of 50 years ago. In order to compete, drugstores and discount and department stores sell food.

Innovations in Food Service

The food service industry is a favorite place for introducing new food products and services. Quite often innovations first used in the food-service industry have been forerunners of innovations in the home.

A striking change in food service has been caused by the introduction of vending machines. Sales of all foods through vending machines in 1963 are estimated at $1.5 billion (22). Total value of all merchandise and food sold through vending machines in 1963 was $3.2 billion, a 9-percent gain over 1962. Tobacco represented 42 percent of sales; confections, 13 percent; dairy products, 3 percent; hot and prepared foods, 5 percent; coffee, 7 percent; soft drinks, 18 percent; and all others, 12 percent. Four million vending machines were in use in the United States in 1963.

The effects of the vending-machine innovation are widespread. Manufacturers alter the size and shape of cans and packages as necessary. Methods of food processing change to meet dispensing-machine requirements. Vending items are especially prepared so they will not be overcooked by prolonged heating. Cafeteria owners consider whether to incorporate vending rooms within their premises or to exclude the machines.

The convenience of these machines appeals to night shift workers and others who prefer the informality and expediency of the vending room to a regular dining facility.

The fully automated restaurant is an outgrowth of food vending. These restaurants of the future are now being used in certain localities. In a typical drive-in of this new type, orders are taken by intercom. A computer translates the order to conveying, cooking, and wrapping equipment. It also calculates the bill and includes the tax. In about 5 minutes the food order, which may include a dozen freshly cooked items untouched by human hands, is ready. Although it is now first being used in hamburger drive-ins, full-scale automation applied to other types of restaurants is feasible. Another innovation is a restaurant where the customer warms partially cooked food at his table in an infrared or microwave oven.

Innovations in convenience foods come rapidly in the food-service market. The away-from-home market consumes about one-third of the frozen foods now used in this country. Two-thirds of the dried potatoes are in packages of a size suitable for this market. Precut meat items provide quality and quantity control. They reduce equipment, space, and labor costs, and improve inventory control. Previously, precooked foods were not popular in this market, but some partially cooked items are now accepted. The food-service industry was the first major user of many of the dehydrated foods, such as dried onions, eggs, and whole milk, presently available on the household market.

Innovations in the Home

In spite of our advanced technology and the advent of prepared convenience foods, the housewife herself still does much of the marketing. In a store she waits on herself and carts her selections to the checkout stand. She delivers the groceries to her home. She does some of the storing and still prepares much of the food.

However, our modern housewife uses innovations in her home that have influenced the whole food-marketing system. Consider a freezer or frozen-food compartment in a refrigerator. This low-temperature storage unit has been a major factor in the development of our present 10-billion-pound frozen-food industry. The otherwise highly developed countries of western Europe do not yet have a full-scale frozen-food industry, its development having been limited by the comparatively small number of home refrigerators and freezers in those countries. As the use of microwave and infrared ovens in homes increases, changes in foods, packages, and our total food-marketing system will occur. Electronic engineers estimate that U.S. housewives may soon be using such ovens.

Electric slicing knives, can openers, blenders, timers, cookers, beaters, sifters, meat grinders, tenderizers, and knife sharpeners influence food-particle size, processing methods, and selling methods.

IMPORTANCE OF RESEARCH IN THE FUTURE OF MARKETING INNOVATIONS

It is difficult to predict when innovations will occur and what their effects will be. In the past, most innovations seem to have appeared at random; in recent years, however, research and development have become more systematic, more persistent, and more wide-ranging. It seems likely that the flow of marketing innovations founded on findings from research will become more dependable, even though individual discoveries may remain as unpredictable as ever. Both industry and Government have taken increased interest in promoting the growth of research and development work.

In 1940, the U.S. Department of Agriculture set up a system of research laboratories to work on utilization of farm products. Farm surpluses and the steady loss of markets to synthetics were important reasons for Government to participate in innovational research. If any industry does not keep up with other industries, it enters into an unfavorable competitive position. The healthy survival of the agricultural industry is a justification for the Government-sponsored program of research and development.

New foods, new uses for fibers, and new food-processing methods have resulted from USDA laboratory work. Examples of products developed at these publicly owned facilities are potato flakes, dehydrofrozen fruits and vegetables, foam-dried tomato and citrus juices, explosive-puffed blueberries, carrots, and beets, WURLANized wool, wash-and-wear cotton, and many others. Some techniques now in common use in food processing have been developed at these laboratories. Although these developments are patented, any U.S. firm or group may apply to the Secretary of Agriculture for use of them.

In addition to research and development work done by the Department of Agriculture and by industry, considerable work in the field of marketing has been done by USDA agencies such as the Consumer and Marketing Service, the Agricultural Research Service, and the Economic Research Service. A substantial part of the program of the Economic Research Service is oriented toward assessing changes that occur in marketing of and demand for farm products. To the extent that these changes relate to innovations, ERS deals indirectly with innovations. The Marketing Economics Division of ERS devotes its efforts to all phases of marketing, including market potentials for new products, services, uses, and industries.

However, most of the money spent by the Federal Government for research and development is not for agriculture, but for defense, space, and atomic energy programs. Yet even in these programs some new food products or processes do result, such as squeeze tubes for feeding in space. In the nonfood industries such as plastics, aircraft, and aluminum, there are numerous examples of innovations that indirectly affect food marketing.

Land-grant colleges also do marketing research, some of which deals with innovational problems such as finding ways to lower costs. Much work is done at the land-grant colleges towards assessing the demand and price relations of individual products and groups of products.

Private food companies also promote and develop research and development programs for food and allied products. Innovations in agricultural products have also been promoted by equipment firms and by processing firms, which recognize innovations as a key element in competition and growth. They know that a slight reduction in costs or a minor improvement in a product may affect their share of

the market. Anticipation of high returns from innovations is a dominating reason for their interest.

Today's corporations earmark a certain dollar amount or a percentage of their sales or income for research in innovations. Some firms have a combined account for research, development, and promotion.

The importance of research to marketing innovations is obvious. The investment and expense required to develop, produce, and distribute a new product on a nationwide scale is of such magnitude that most firms will not handle new products unless research reveals that the market potential is strong. Therefore, the outlook for new agricultural products is highly dependent upon the findings of marketing research. The marketing company itself may do the research or have it done by a specialized marketing research organization.

New products developed by Federal Government laboratories pose special marketing research problems. Many new inventions from Government laboratories are not immediately accepted and put on the market by industry. Their public patents may delay their adoption by private industry, since private companies understandably prefer exclusive rights. Marketing research by Government may overcome this obstacle to some extent by pointing out the commercial potential of the innovation. A firm thus would not be burdened with the whole cost of obtaining research data necessary for the initital decision on whether to investigate the market.

Market research by a Government agency, if closely coordinated with the rest of the agency's research and development program, performs a dual function. First, it uncovers market facts concerning new products. This helps speed the process of getting new products or processes on the market. Second, it may help develop new product concepts for laboratory research. As a part of this program, it tests embryonic products so at least a little market information is available to technical researchers at the very early laboratory stage of development.

A report of the National Science Foundation shows that $16 billion was spent on research and development in the United States in 1962. Government-sponsored industrial research accounted for nearly three-fourths of this amount (19). One report estimates the amount of research and development expenditures at $13 billion in 1964 (2). It is expected that the funds used for this purpose will increase in the years to come.

Despite impressive contributions of innovations, there are questions about the immediate value of increasing research and development expenditures to promote them. Since 1952, our economic growth rate in this country has increased slowly--averaging about 3 percent per year in the 1952-61 decade (16). Since 1962, however, the growth rate has been increasing and now averages about 5 percent per year. This stepped-up rate may be partly the delayed result of research and development expenditures made in earlier years. However, little is known about the return from such expenditures for research and development and it is difficult to assess their value.

Research and development expenditures on food accounted for about 1 percent ($127 million) of the total spent on research and development in the United States in 1964. This is low when we consider that food is our largest industry. Important competitors of agricultural products, the chemical and allied products industries, have been increasing their research and development expenditures by 5 to 6 percent

a year for the past decade. In this same decade, agriculture lost many of its markets. We may expect further encroachments by nonagricultural source materials in several areas.

SOME PROSPECTIVE INNOVATIONS

Since each innovation is the application of an invention, we may look at inventions of today and expect to see some of them as innovations of tomorrow. Most of the innovations of the past decade were discussed as possibilities in the preceding years.

There are many recent scientific discoveries awaiting application in the field of agricultural marketing. Laser and Maser light beams, for example, appear to be so important that their effects will be felt over the whole economy. Currently used only in relatively rare cases such as delicate eye operations, their application to food marketing is not yet even considered. Gases may have new and wider applications in marketing: low-temperature freezing using nitrogen and carbon dioxide at temperatures ranging downward to 320° F. below zero is just now becoming a commercial reality. Irradiation energy in one form or another will surely affect the storage, handling, processing, and marketing of many agricultural products. Use of microwaves and sound waves appears almost certain to change food processing. Changes in drying, fermentation, and canning methods also are important. Edible spun proteins derived from soybeans may be a future substitute for meat and dairy products.

Changes now being initiated in food retailing and wholesaling lead us to envision even greater changes in the years ahead. The grocery store of the future will not be a processing plant, but rather a bazaar, a showplace, a selling exchange. Concepts such as telephone and TV selling, instore delivery, and credit-card or coin-operated machines drastically alter selling methods. Packaged items will look more natural and be fully visible, yet be more competely protected. Longer shelf life will permit mass displays, not only of the usual canned items but of foods we now consider perishable. Stores may continue to do finishing of food products, but in the future most of these functions will be done in centralized locations rather than in the store itself. Completely prepared foods such as are now sold only in delicatessen stores or in eating places will be common.

USDA researchers have developed edible coatings for food. A high-quality dried whole milk powder may be a major breakthrough of the dairy industry in the 1960's. Aerosol containers make messy foods usable and convenient. Low-cost fish flour and foods derived from algae may help solve world nutritional problems.

Anticipated new industrial uses of agricultural products include graft-polymers combining natural and synthetic fibers. These will be used to create new types of films, sheets, fabrics, or nonwoven web-type products. Organic synthesis using fats, carbohydrates, celluloses, and proteins from agricultural products may end up as apparel, or as household and industrial products. Entirely new products will be developed to meet needs unrecognized at present.

Innovations in food and fibers are likely to increase as more effort is put into creating them. These changes will have a wider impact. More knowledge will be available about changes themselves, and better decision-making will result.

SUMMARY

Innovations promote economic growth. Pursuit of profit keeps them coming forward. Competition spreads their effects and other firms benefit. Individuals,

firms, industries, and whole economies are affected and changed. Some are helped; others are hampered. Innovations require adjustments, and those unable to adapt are left behind.

Certain conditions in the economy may influence the appearance of innovations. Competition between firms creates a need for new ideas. Changes in population characteristics lead to different eating and living habits. The rise in the percentage of working women may be both the cause and effect of innovations in prepared foods. Higher incomes, higher standards of education, and more leisure time also provide a favorable climate for the introduction of new methods and processes.

Important marketing innovations of recent years include new foods, fibers, handling methods, and processes. As a result, whole new industries are appearing. An increasing array of convenience foods are now available frozen, canned, and dehydrated. Innovations in wool and cotton help these fibers compete more effectively with synthetics, which are also innovations. New machines handle particular products, and packaging improvements match advances in container filling. Some of our newer foods are now possible because of container innovations. New methods are constantly being tried in the whole food industry. Changes in food processing techniques make it possible to produce food where growing costs are lowest.

Larger firms emerge as smaller firms combine and as present firms expand their lines of products or services. The increased size of our present-day supermarkets is counterbalanced by another trend toward small neighborhood convenience stores. Nonfood firms now engage in food processing. Drugstores, department stores, and discount houses sell groceries, and grocery stores handle items usually sold by these other stores. Retail functions are being centralized, with more efficiency as a result.

Vending machines and fully automated restaurants are innovations in the food-service industry. In the home, electronic ovens and a variety of electric appliances from the freezer to the can opener influence further changes in the food industry as a whole.

Research is important to the development of innovations. Private companies and land-grant colleges engage in marketing research, as does the Federal Government. New products and methods have been developed by Government laboratories, and certain agencies specialize in marketing research. Time and money spent on research and development increase every year.

Science and invention are producing ideas which will have future application in processing, wholesaling, retailing, and other aspects of agricultural marketing. But the process of innovation itself is changing, and we find that we really know little about this great economic force. How do innovations affect our marketing system, as well as the various groups involved? How do we maintain a continuous flow of innovations? How do we adjust to innovational changes with a minimum of disruption and hardship? We need research to answer these questions.

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